

Figure 1 Typical overlay patterns or completed alignment attributes

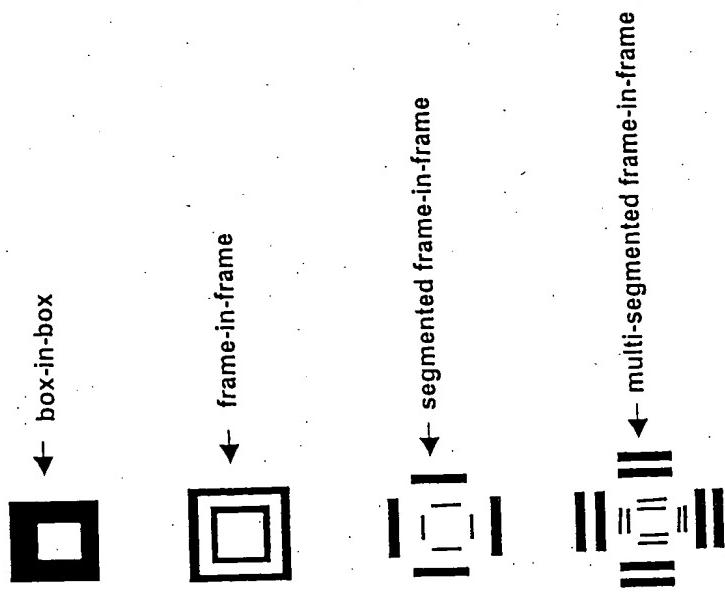
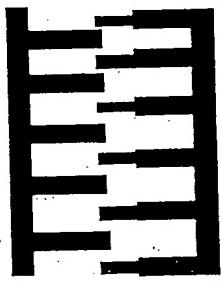


Figure 2 Typical optical verniers



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Wafer stage

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Figure 3 Reticle in example by prior art

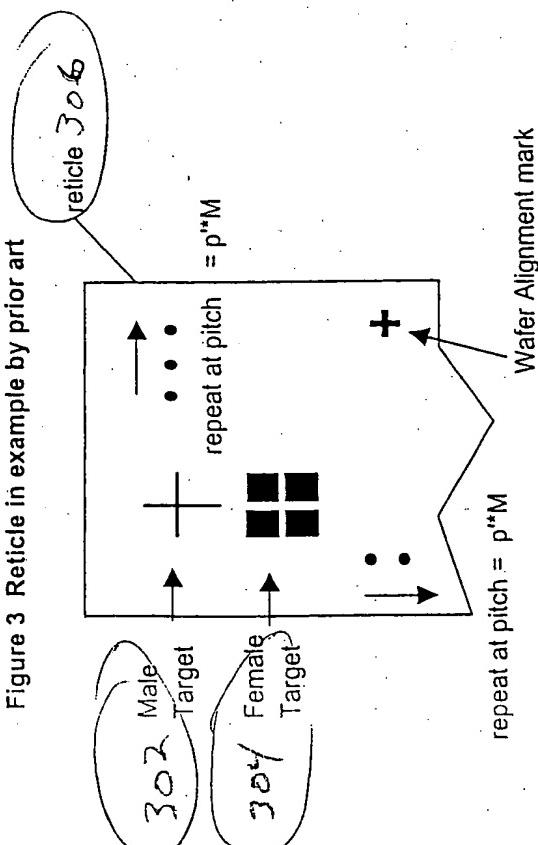
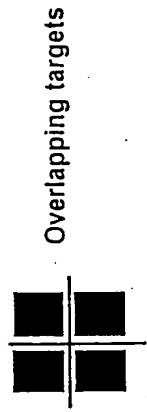


Figure 4 Overlapped male and female target pairs



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Figure 5 Detail of reticle of figure 3

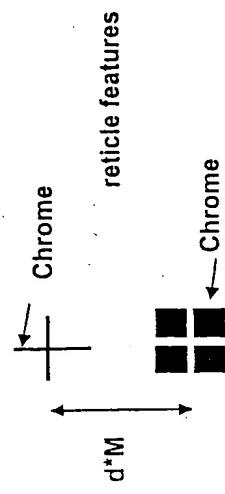
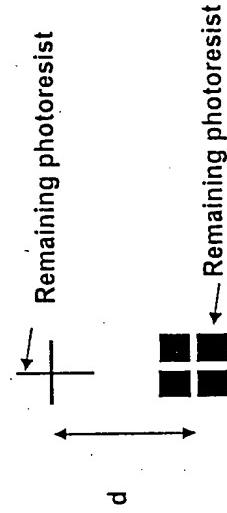


Figure 6 Features of figure 5
in developed positive photoresist



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Figure 8A Outer box 2 on the wafer, M=4. um = microns, Dark=chrome, white = clear.

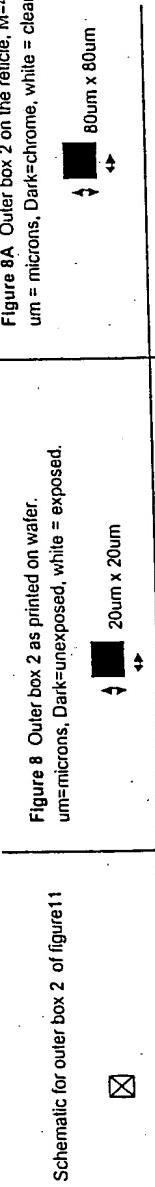


Figure 7 Schematic for outer box 2 of figure 11

Figure 10 Inner box 1 as printed on wafer.
 um=microns. Dark = unexposed, white = exposed.

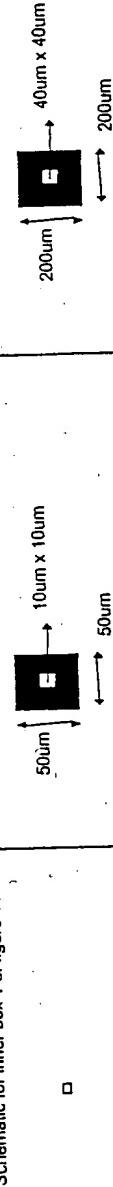


Figure 11 Schematic for a 2-dimensional overlay *relicle*

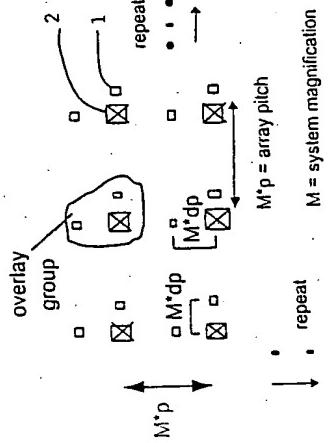


Figure 8A Outer box 2 on the felicie, M-4. um = microns. Dark=chrome, white = clear.

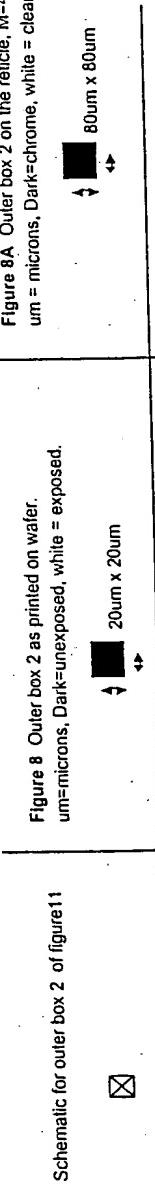


Figure 10 Inner box 1 as printed on wafer.
 $\mu\text{m}=\text{microns}$, Dark = unexposed, white = exposed.

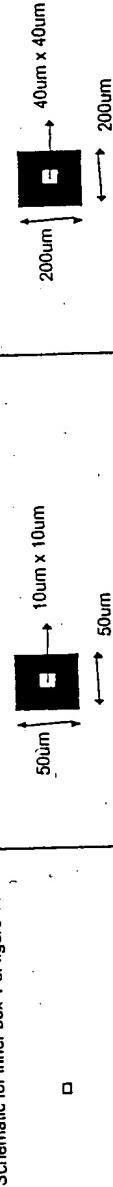


Figure 12 Typical vehicle overlay set or overlay group as projected onto water (3 featured parts); dark = unexposed

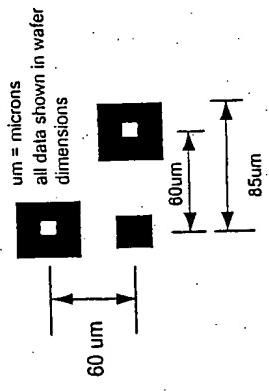


Figure 10A Inner box 1 on the reticle, M=4.
 $\mu\text{m}=\text{microns}$. Dark = chrome, while = clear.

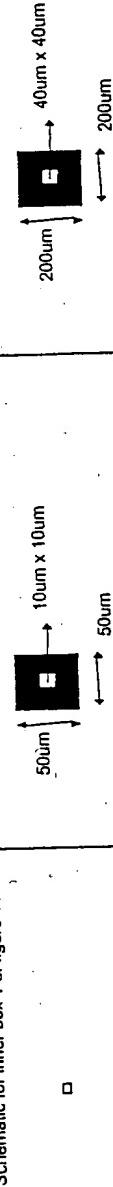
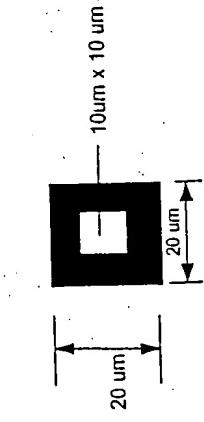


Figure 12A Completed alignment attribute combining figure 8 and with its complement (figure 10). dark = unexposed, white = exposed.



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Figure 13 Overlay target patterns (x-overlap
creating interlocking columns)

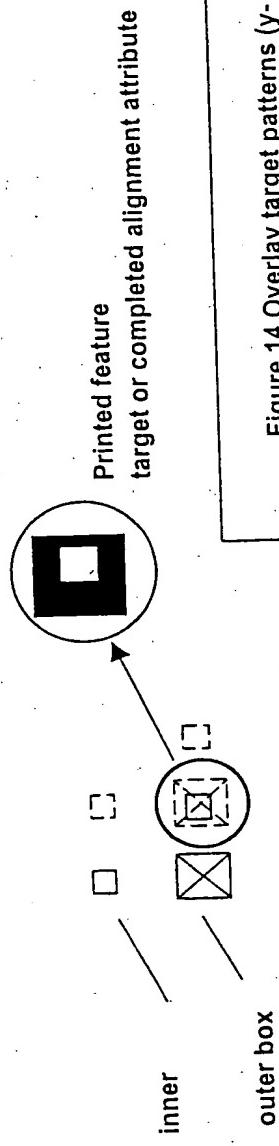
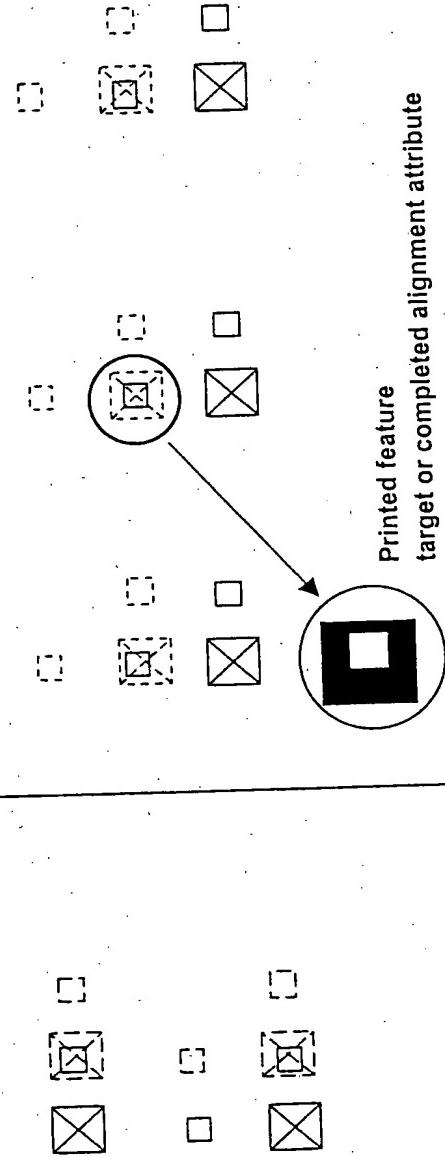


Figure 14 Overlay target patterns (y-
overlap creating interlocking rows)



Printed feature
target or completed alignment attribute

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Figure 14A Interlocking Exposure of 4 fields (solid, dashed, dotted, heavy solid lines).
 CA = completed alignment attribute, UA = unuseable alignment attribute

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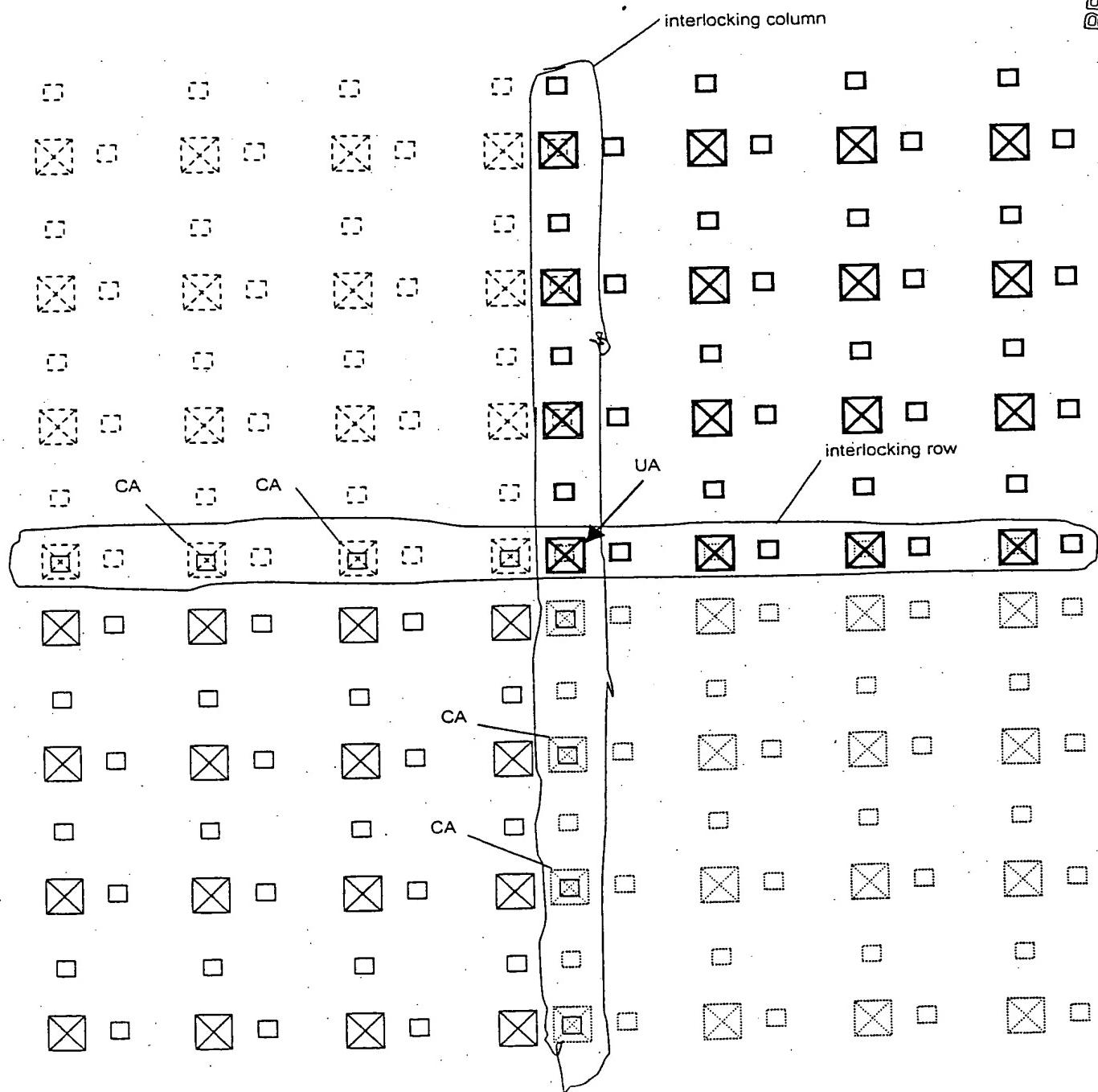


Figure 15 Preferred embodiment / process flow

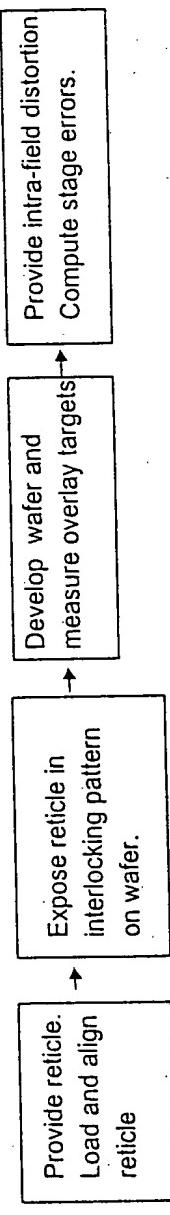


Figure 16 First variation of the preferred embodiment / process flow

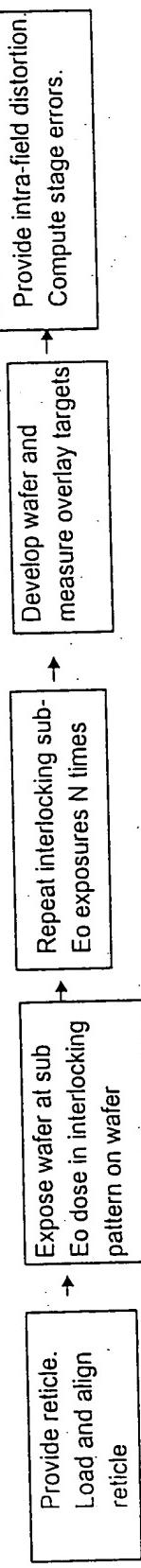


Figure 17 Second variation of the preferred embodiment / process flow

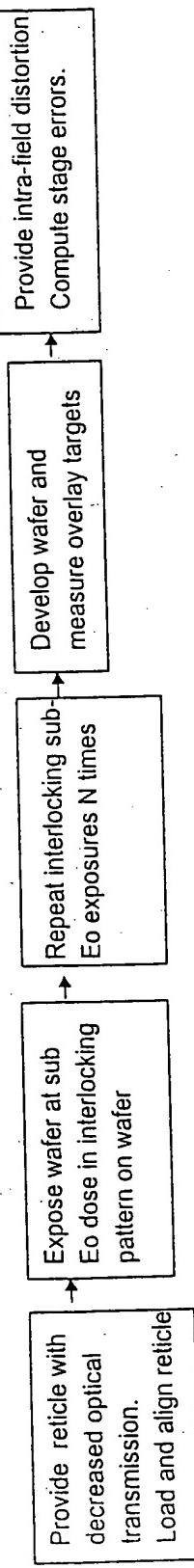


Figure 18 Common causes of overlay or placement error (Inter-field and Intra-field)

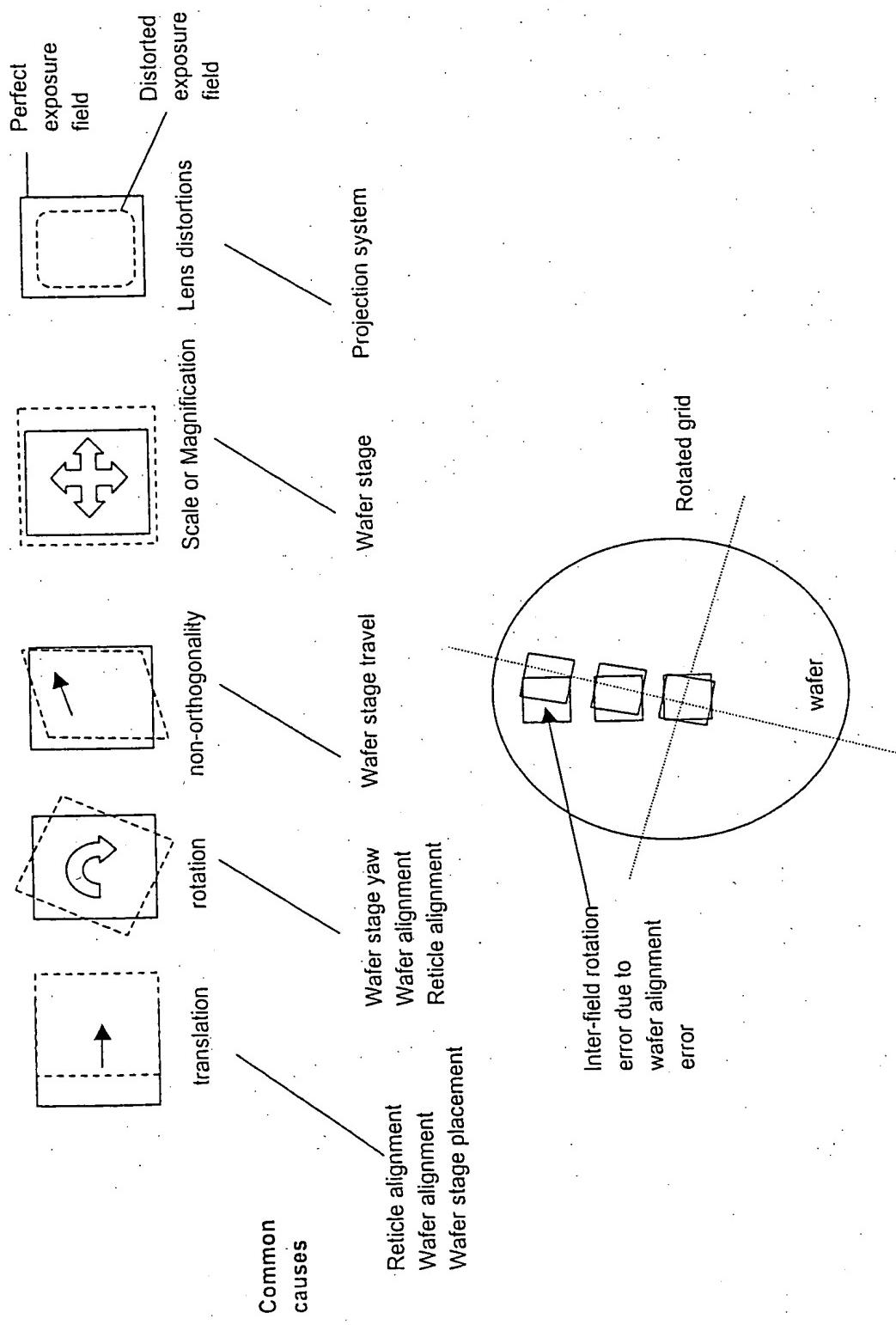


Figure 19 Photolithographic stepper or scanner system

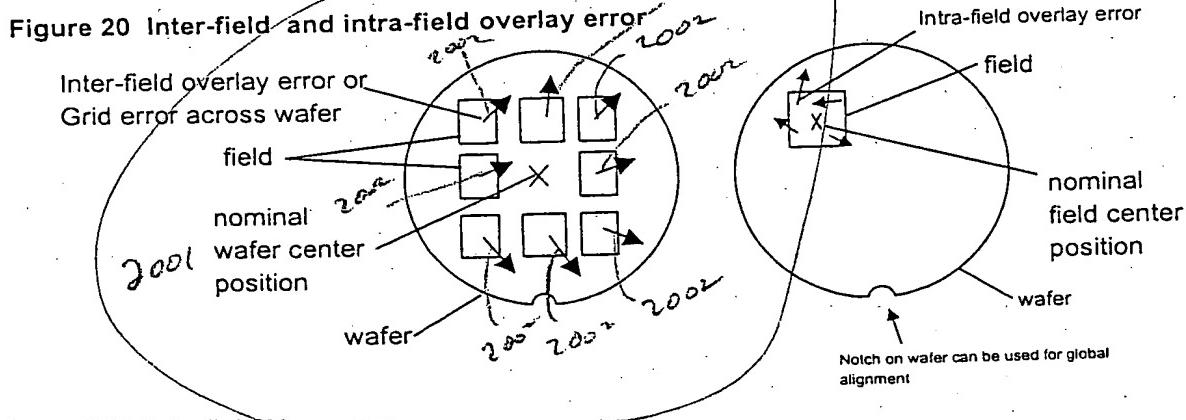
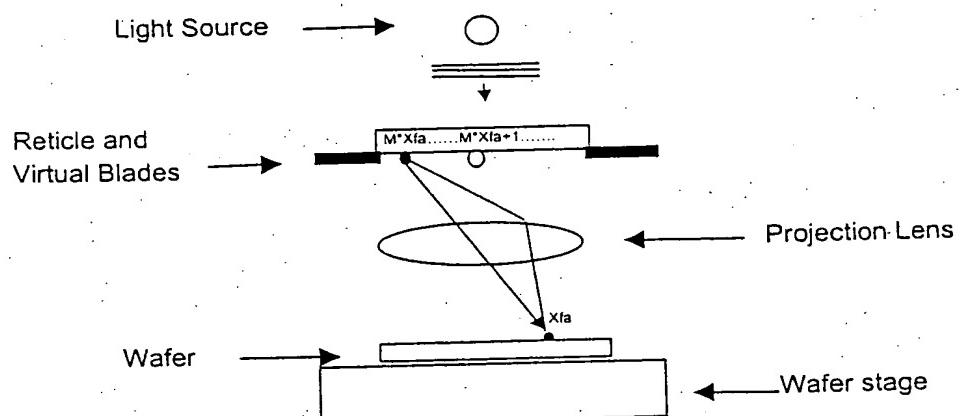
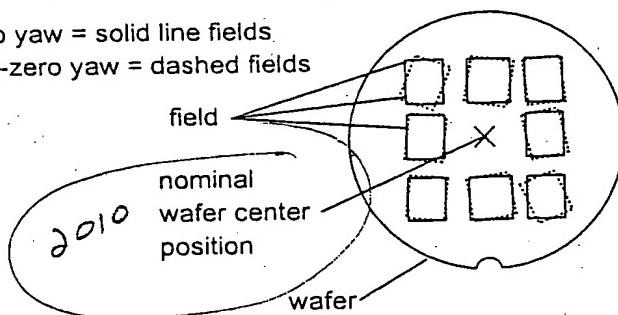


Figure 20A Interfield Yaw error

zero yaw = solid line fields
 non-zero yaw = dashed fields



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Figure 21 Preferred Embodiment Overlay reticle

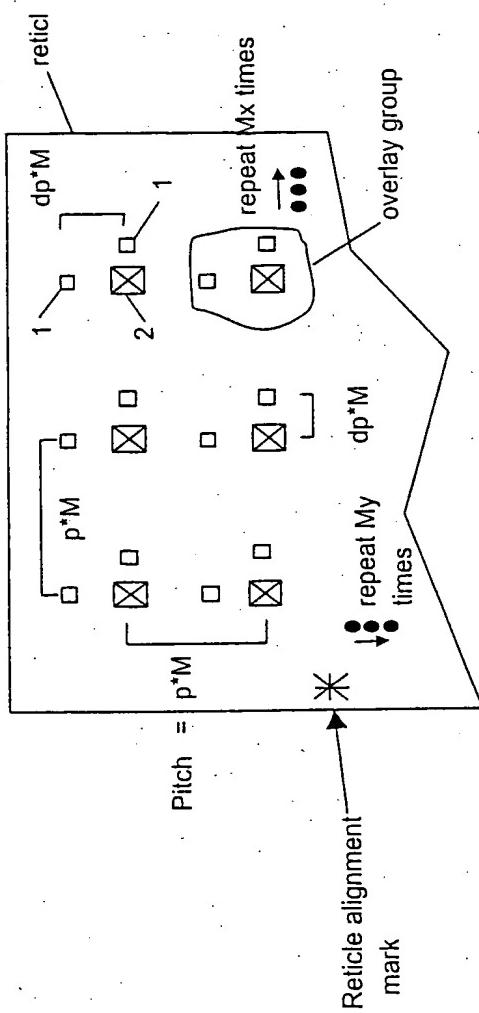


Figure 21B Side view of reticle of figure 21

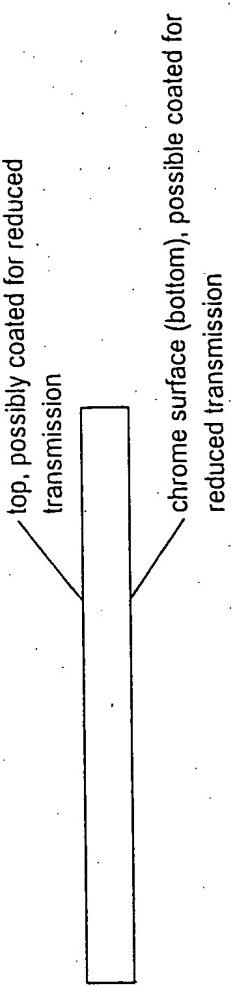


Figure 22 Prior art, stage matching and wafer stage error

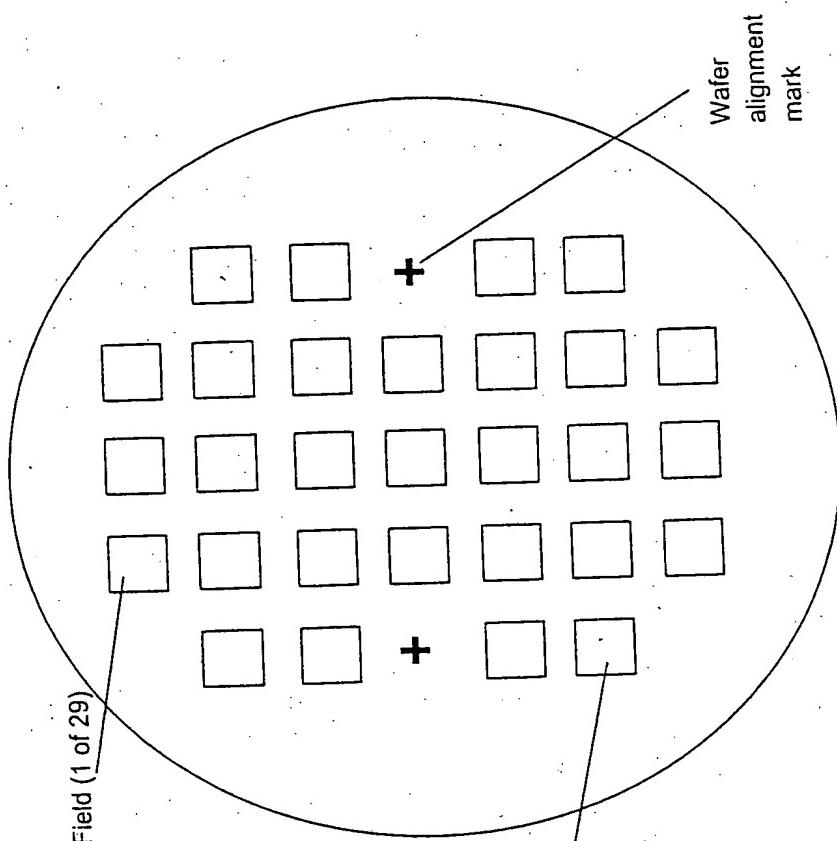


Figure 23
11 by 11 target array

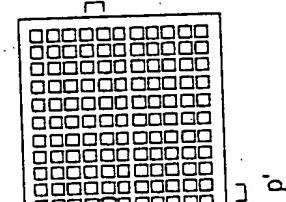


Figure 24
Targets

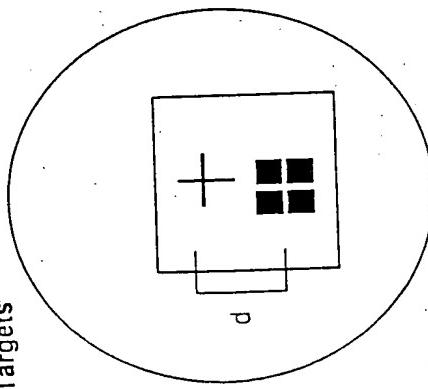


Figure 26 Tiled or interlocking wafer schematic
 for self-referencing methodology

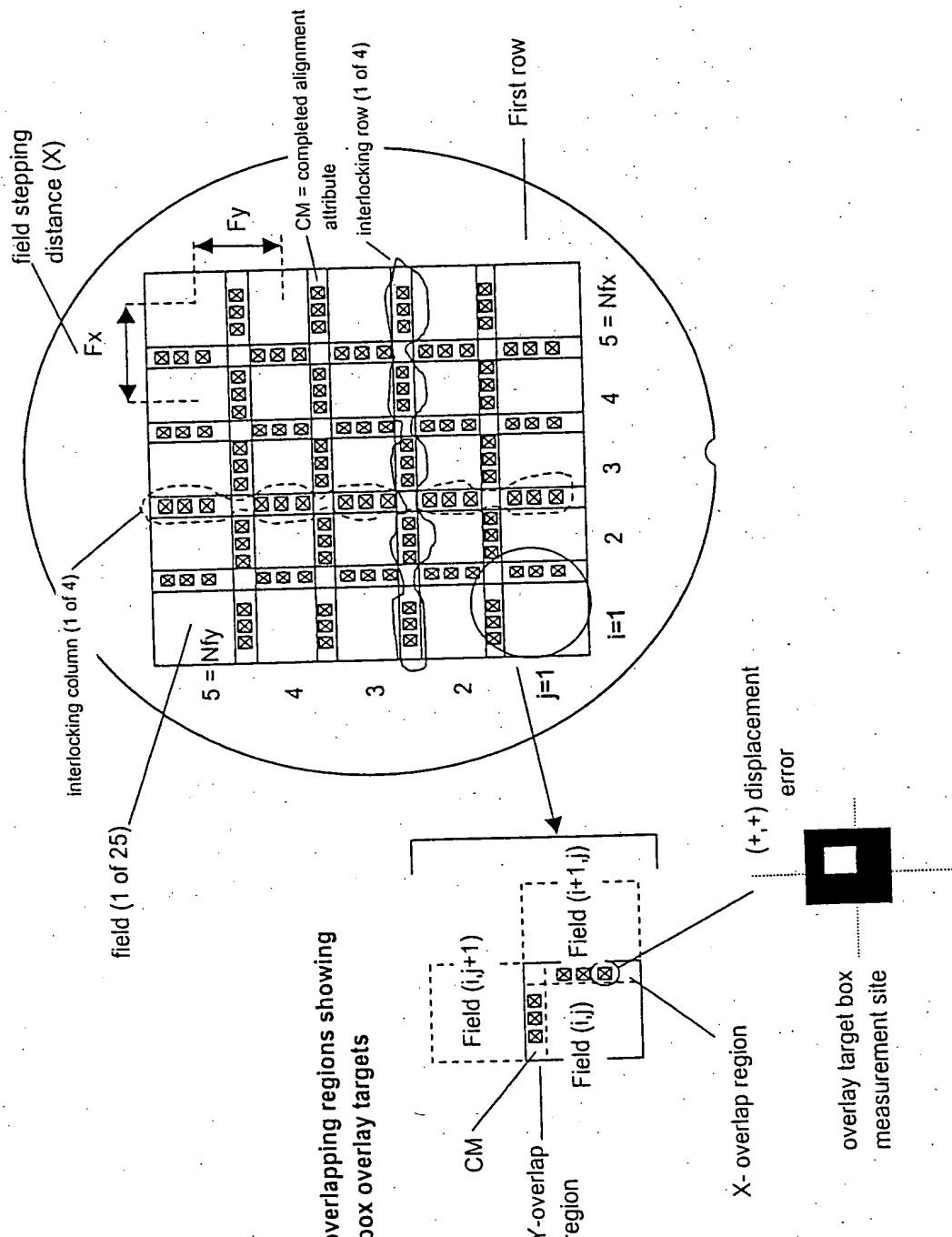


Figure 25 Typical overlapping regions showing
 3 box-in-box overlay targets

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Figure 27 Overlay error
vector plot

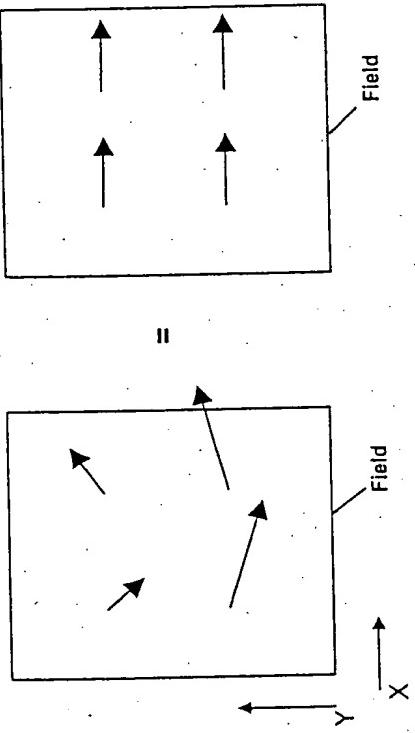


Figure 28 Translation overlay
vector plot

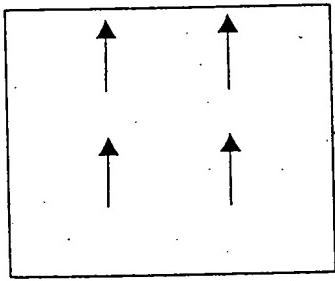


Figure 29 Rotation
overlay vector plot

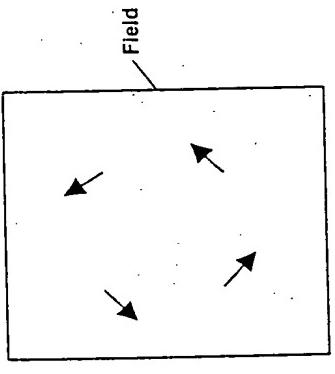


Figure 30 Overlay measurement

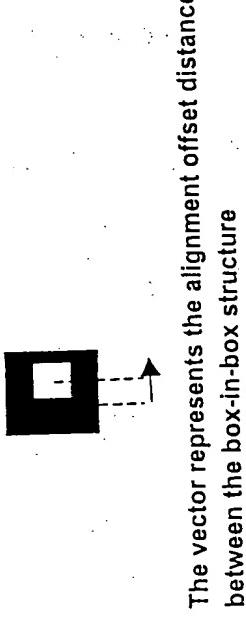
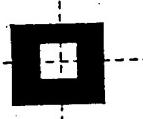


Figure 31 Perfectly centered
Box-in-Box structure



The vector represents the alignment offset distance
between the box-in-box structure

Figure 32 Wafer alignment mark reticle

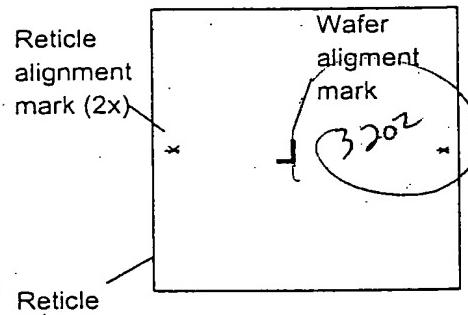


Figure 33 Inner box reticle

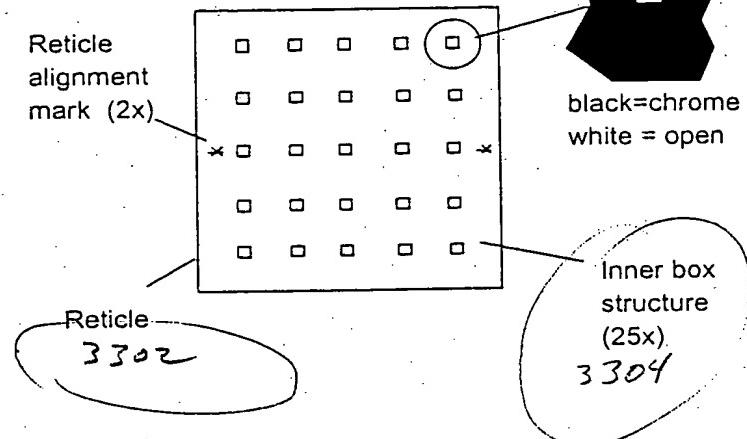


Figure 34 Reference wafer layout

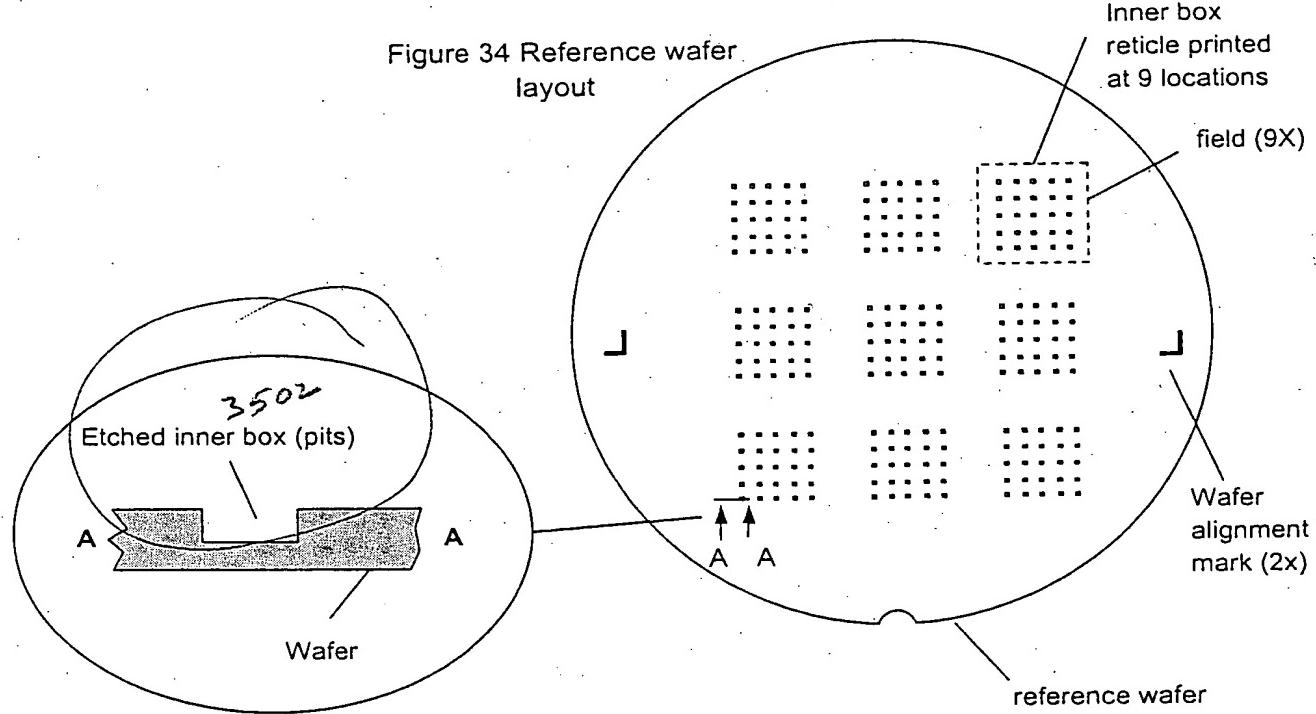


Figure 35 Cross section of inner box

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Figure 36 Outer box reticle schematic

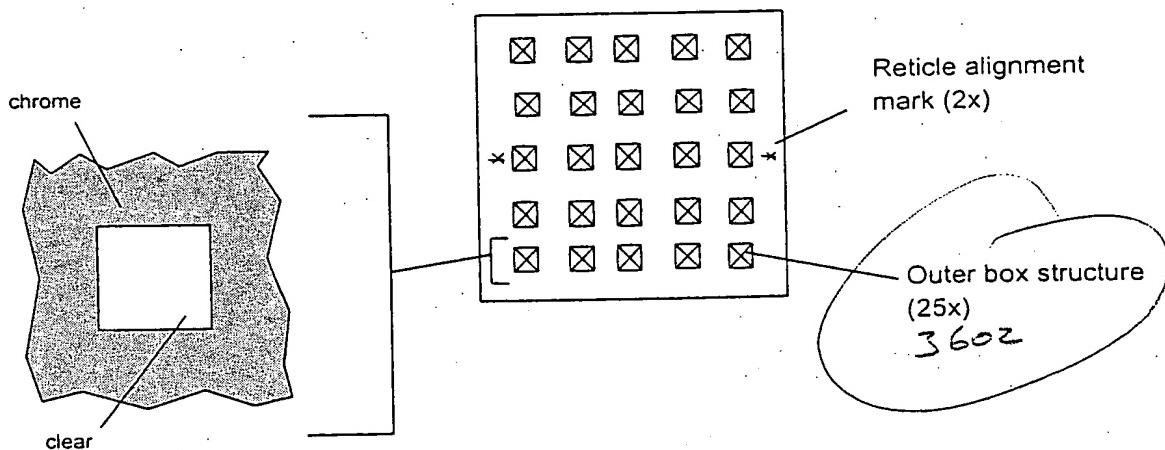


Figure 37 Outer box reticle detail

Figure 39 Box-in-Box cross-section AA

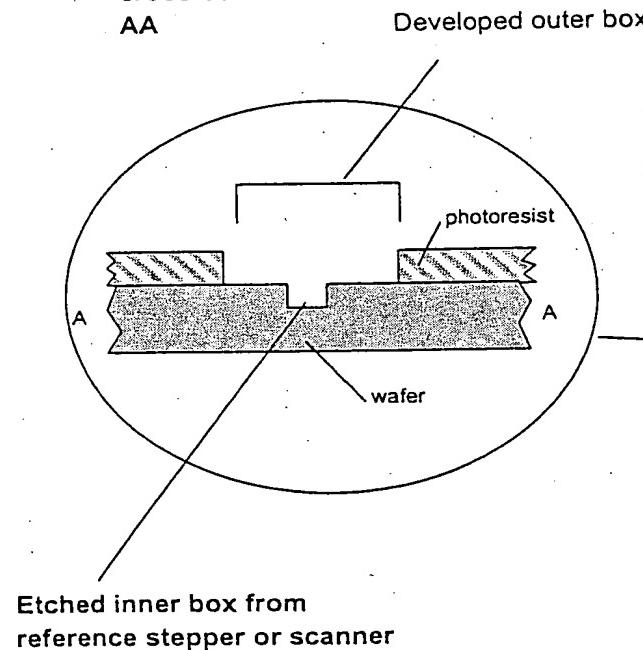
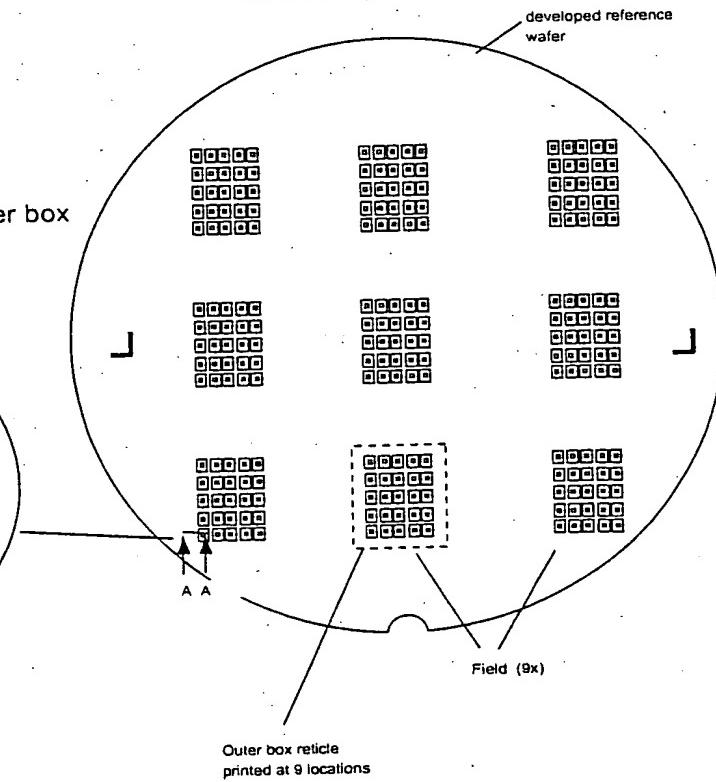


Figure 38 Developed reference wafer ready for overlay measurement



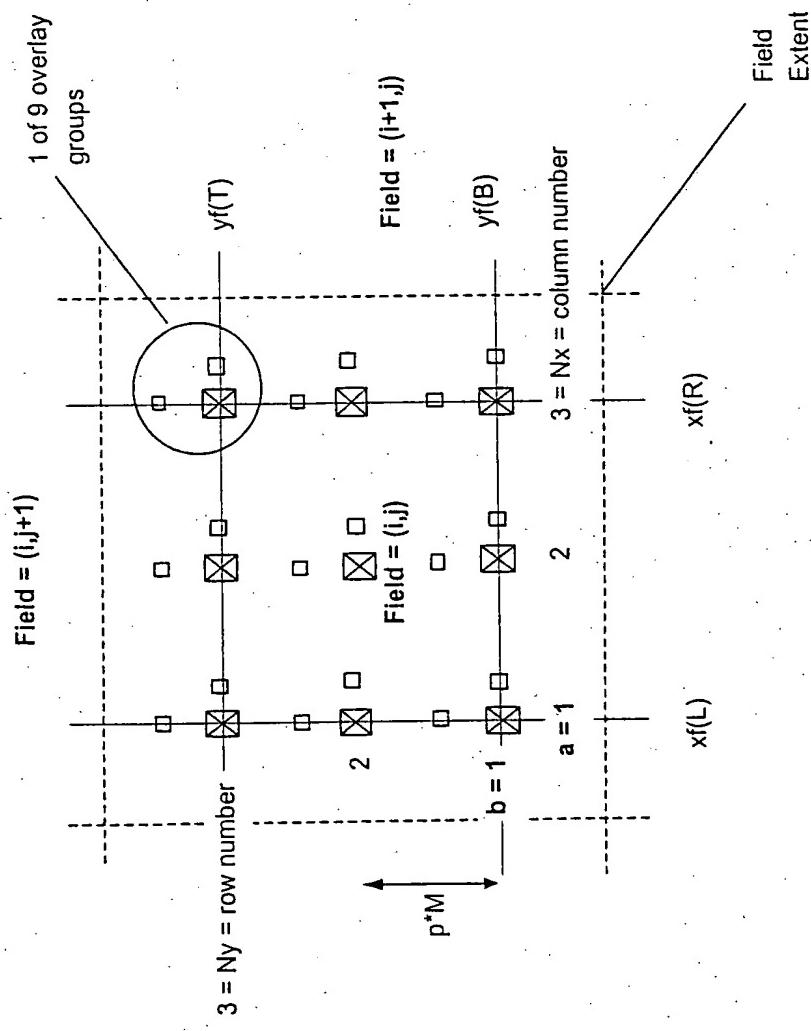


Figure 40 Inter-field and intra-field indices

Figure 41 Alternate overlay reticle schematic with alternating inner and outer box structures on pitch p^*M

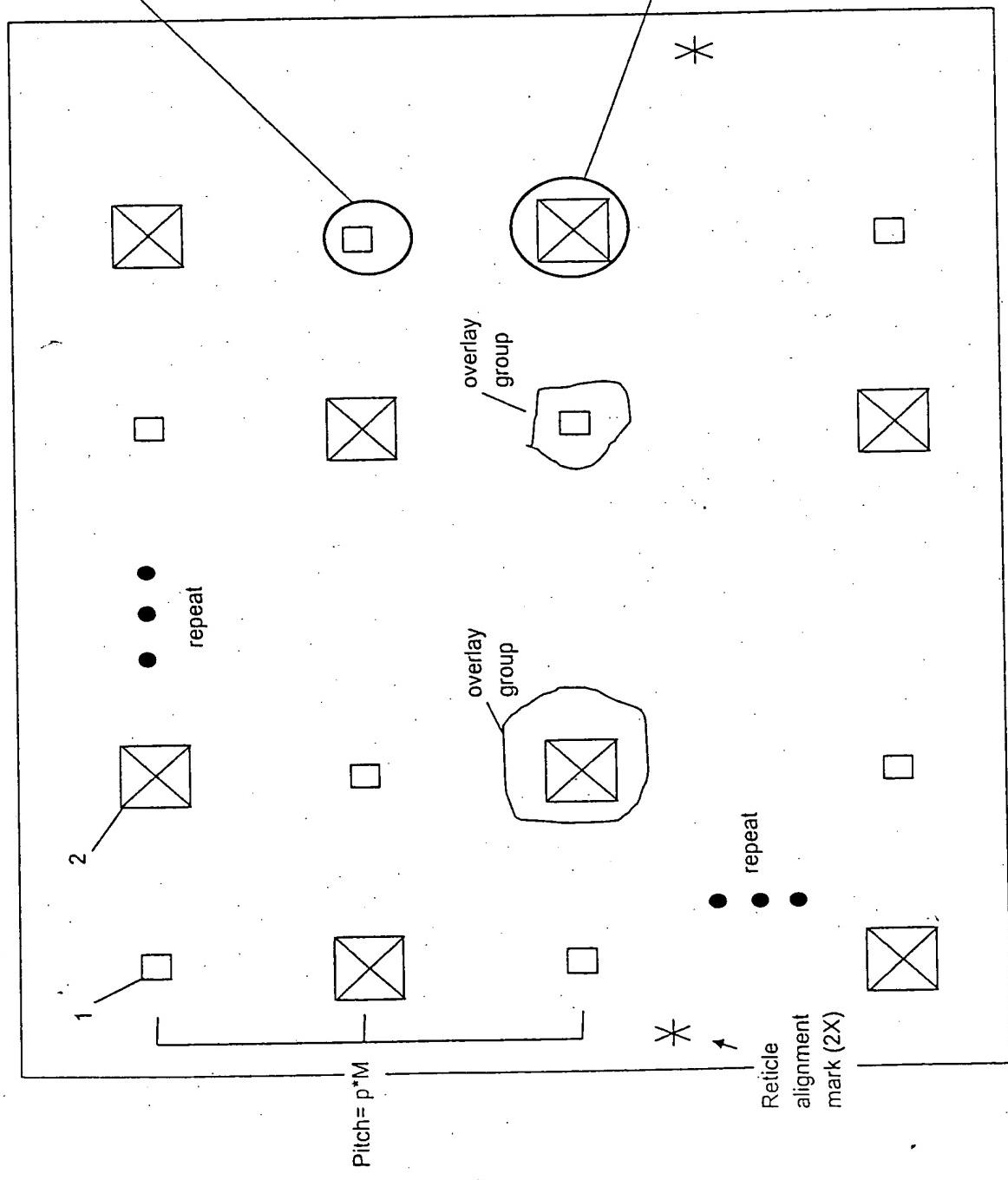


Figure 42 inner box, 1, reticle pattern. Black = chrome, white = clear.



Figure 43 outer box, 2, reticle pattern. Black = chrome, white = clear.



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Figure 44 Partially exposed field and
interlocking box-in-box structures along
Field (i+1,j)'s left edge

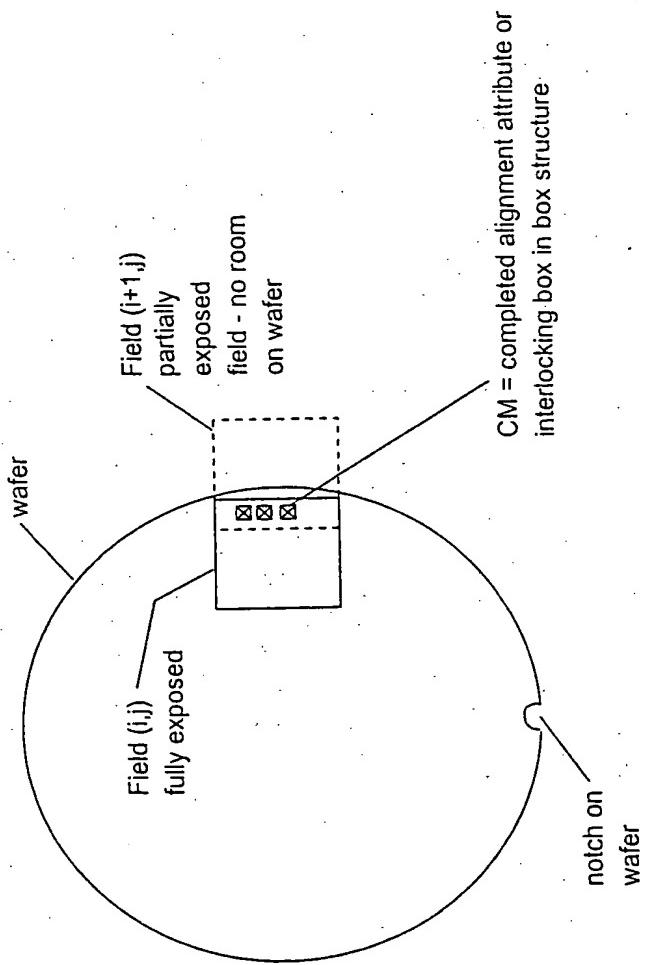


Figure 45 Simple reticle arrangement for accomplishing the method of this invention

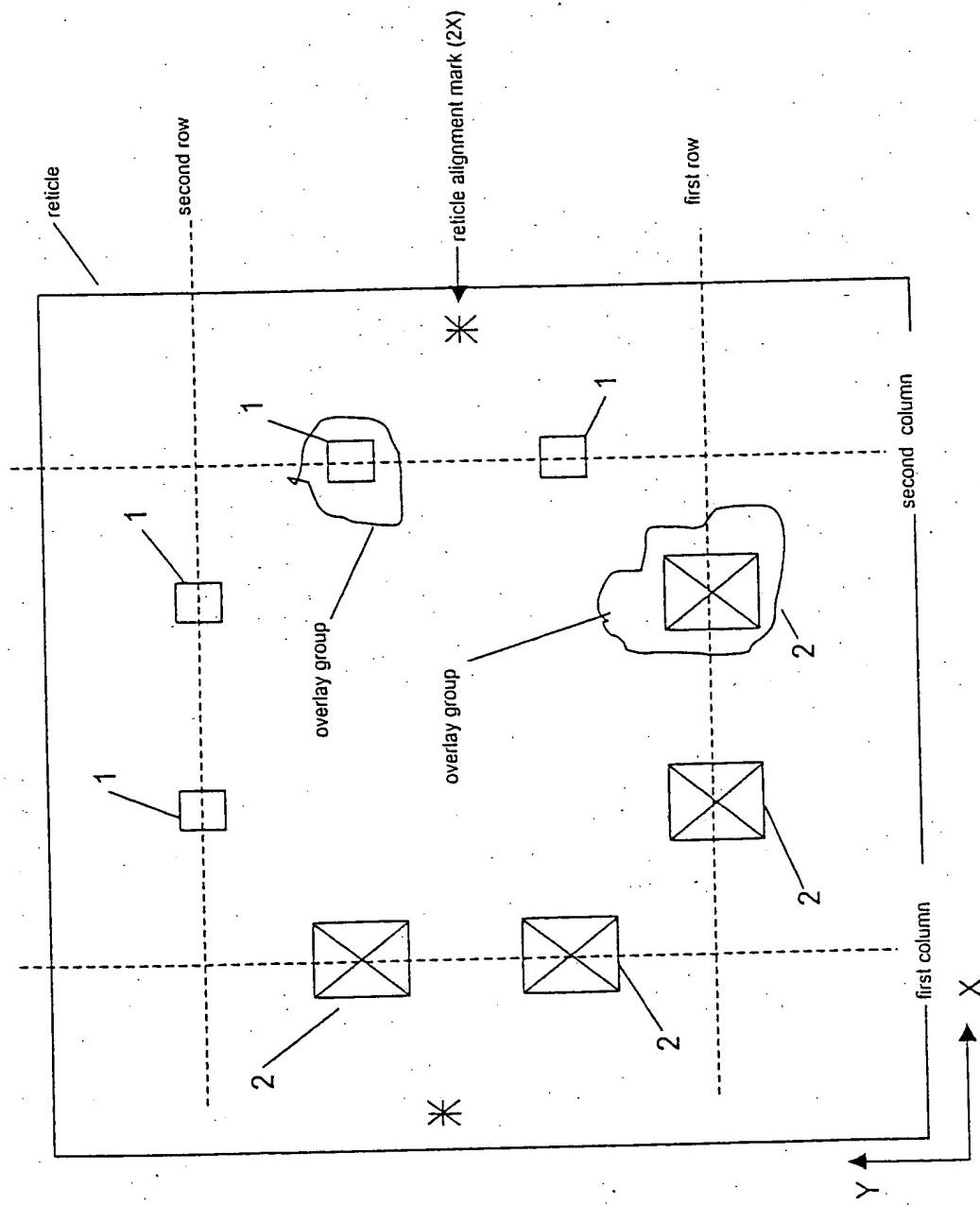


Figure 46 Final results of the method of this invention. Length units = microns. Yaw units = microradians. xG, yG = nominal field center position. dxG, dyG = offset of center of field. Qg = yaw of field. Fx, Fy = field stepping distance, srel = grid scale - intra-field scale (parts per million), D=wafer diameter.

